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Re-emergence of injecting drug use-related HIV despite a comprehensive harm reduction environment: a cross sectional analysis

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The lead author* affirms that he had full access to all of the data in the study and had final responsibility for the decision to submit for publication.

Abstract

Background

In 2015, an outbreak of Human Immunodeficiency Virus (HIV) was identified among people who inject drugs (PWID) in the Greater Glasgow and Clyde (GGC) area of Scotland, an area which distributes over one million needles and syringes per year. This is the largest such incident in the UK for 30 years. This study provides the first epidemiological analysis of the impact of the outbreak on HIV prevalence trends in the population and the individual and environmental risk factors associated with infection.

Methods

Four cross-sectional anonymous bio-behavioural surveys of almost 4000 PWID attending services providing injecting equipment across GGC between 2011 and 2018 were analysed. Participants were recruited by trained independent interviewers and eligible if they had a history of injecting drug use, either current (within the past six months) or historical. Interviewers asked participants questions about demographics, behaviours and service use and to give a dried blood spot sample to test anonymously for the presence of blood-borne viruses. Trends in prevalence of HIV infection, risk behaviours, and intervention coverage were examined. Logistic regression was used to determine individual and environmental factors associated with HIV infection.

Findings

Between 2011-12 and 2017-18, HIV prevalence in GGC rose from 0·1% (1/927) to 4·8% (39/821) overall, and from 1·1% (1/87) to 10·8% (25/231) in Glasgow city centre, respectively. Over the same period, the prevalence of cocaine injecting in GGC rose from 16% (129/806) to 50% (291/583) overall, and from 37% (26/70) to 77% (117/153) in Glasgow city centre. HIV infection was more likely among PWID who had: participated in 2015-18 versus earlier survey years (AOR 3.4, 95% CI: 1·7 to 6·7); been homeless in the past six months versus not homeless in the past six months (AOR 3·0, 95% CI: 1·7 to 5·0); multiple incarcerations since first began injecting versus low number of incarcerations (AOR 2·1, 95% CI: 1·2 to 3·7); and injected cocaine within the past six months versus not injected cocaine in the past six months (AOR 6·7, 95% CI: 3·8 to 12·1). Age per one-year of increase was also a significant factor (AOR 1·1, 95% CI: 1·0 to 1·1). Gender showed borderline significance with females more likely to be HIV positive than males (AOR 1·7, 95% CI: 0·9 to 3·2).

Interpretation

Despite high coverage of harm reduction interventions, Glasgow has experienced a rapid rise in prevalence of HIV among its PWID population, associated with homelessness, incarceration and a major shift to injection of cocaine. Robust surveillance through regular HIV testing of high risk populations is critical to ensure outbreaks are detected and rapid responses are informed by the best available evidence.

Funding

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Research in context

Evidence before this study

People who inject drugs (PWID) are at risk of Human Immunodeficiency Virus (HIV) transmission through sharing of injecting equipment and unprotected sex. Opioid agonist therapy and needle and syringe programmes are effective in preventing HIV transmission among PWID. In recent years, a number of outbreaks of rapidly transmitting HIV infection among PWID have been observed in areas of Europe and North America where incidence has been low since the 1980's. We searched PubMed on 1 June, 2018, with the search terms "HIV" AND "PWID" AND "Injecting" AND "outbreak" for publications from Jan 1, 2010, to May 31, 2018, restricted to English language, but with no restriction on geographical location.

Added value of this study

In the context of outbreaks of HIV among PWID reported globally in the last 10 years, this is the first to investigate the determinants of infection using an approach which combines both statistical power and robust survey methods applied consistently over time.

Implications of all the available evidence

Availability of harm reduction services is not sufficient on its own to prevent HIV outbreaks occurring among highly vulnerable populations. Increased injecting of stimulants among high risk populations potentially presents a threat to global HIV elimination strategies. Regular and robust surveillance, through HIV testing of high risk populations, is critical to ensure outbreaks are detected and rapid responses are informed by the best available evidence.

Introduction

People who inject drugs (PWID) are at risk of Human Immunodeficiency Virus (HIV) transmission primarily through sharing of injecting equipment,[1] but also through unprotected sex.[2] Internationally, there are estimated to be 15·6 million PWID of whom 17·8% are living with HIV.[3] Prevalence of HIV among PWID is highest in Latin America (35·7%) and Eastern Europe (24·7%); Western Europe has one of the lowest prevalence rates internationally (4.5%). In recent years, a number of outbreaks of rapidly transmitting HIV infection among PWID have been observed in areas of Europe and North America where incidence has been low since the 1980's.[4-6] In Scotland, there are an estimated 15,000-20,000 PWID.[7-8] Major outbreaks of HIV among PWID were identified in the 1980s in the cities of Edinburgh[9] and Dundee.[10] Since then, HIV prevention has been effective in controlling the spread of infection among PWID for over three decades, largely as a result of widespread availability of Opioid Agonist Treatment (OAT), needle and syringe programmes (NSP), and anti-retroviral treatment (ART) for HIV infection. Until recently, the number of newly diagnosed HIV infections among PWID in Scotland remained stable at around 15 per year; however in 2015, the annual number rose to 52. The vast majority (n=47) of these new cases were from the Greater Glasgow and Clyde (GGC) area which incorporates Glasgow, Scotland's largest city. The outbreak has persisted with over 100 new cases identified during 2015-17. Routine viral sequence testing of the Glasgow cases identified a rarely observed HIV subtype C virus in the majority of samples.[11] Furthermore, phylogenetic analysis revealed that this strain has not been identified outside of Scotland and that transmission was occurring rapidly.[12]

The current HIV outbreak in Glasgow is the first community-based outbreak among PWID in the UK for over 30 years. Further, and most unusually in comparison to other recently observed outbreaks of HIV among PWID internationally, it was occurring despite the existence of a comprehensive harm reduction environment. The high proportion of women involved in the outbreak has also increased concerns regarding sexual transmission. There is an imperative to learn about the circumstances of HIV outbreaks among PWID in countries with historically low prevalence and tackle complacency in prevention if we are to maintain progress in tackling the HIV epidemic.

Using data from Scotland's decade-long national surveys of PWID,[13] this paper aims to: (i) examine the prevalence of HIV over time among PWID in GGC and (ii) assess the individual and environmental risk factors associated with a sudden increase HIV infection among the population of PWID in GGC.

Methods

Study design and data sources

The Needle Exchange Surveillance Initiative (NESI) is a voluntary, anonymous, cross-sectional survey of PWID attending community-based services providing injecting equipment in mainland Scotland to monitor rates of blood-borne virus (BBV) infection and risk behaviours in this population.[13] During 2008-2018, six national surveys have been undertaken, each involving a sample of approximately 2,500; GGC contributing approximately 1,000 participants per survey. Eligibility criteria are a history of injecting drug use, either current (within the past six months) or historical. Around 80% of each survey is comprised of current PWID. Trained interviewers ask participants questions about their demographics, behaviours and service use (https://www.hps.scot.nhs.uk/resourcedocument.aspx?id=5866), and to give a dried blood spot (DBS) sample to test anonymously for the presence of hepatitis C and, in some surveys, other BBVs. HIV testing was included in surveys conducted in GGC from 2011 onwards. A £5 shopping voucher is provided to individuals who complete the survey as compensation for their time. The interviews are carried out by trained researchers who obtain informed consent from all participants prior to data collection. Ethical approval for the NESI survey was granted by the NHS West of Scotland Research Ethics Committee (REC Ref: 08/S0709/46).

Outcomes

In each of our three models, the outcome measure was HIV infection status, derived from laboratory testing of DBS samples using a 4th generation HIV antigen/antibody combination assay.[14] NESI sampling and laboratory testing methods have been previously described.[13]

Statistical analysis

In total, data from 3,641 PWID recruited in GGC as part of the four NESI surveys conducted during 2011-18 were available for descriptive analysis following the removal of duplicate survey participants within each survey (i.e. those who participated more than once in a particular survey) using basic identifiers (initials, gender, date of birth) and missing data.

In our multivariate analysis, data from 2,712 PWID recruited in GGC as part of the four NESI surveys conducted during 2011-18 were available following the further removal of duplicate survey participants across surveys (i.e. those who took part in more than one survey) and questionnaires with insufficient or missing data. Unadjusted and adjusted logistic regression was used to identify risk factors associated with HIV.

We assessed outcomes according to relevant 'individual' and 'environmental' risk factors for HIV using the work of Jolly and colleagues as a guiding definitional framework.[15] In addition, our modelling strategy was underpinned by the widely accepted minimal criterion for sample size considerations in logistic regression analysis; ten events per variable.[16] As our sample consisted of 69 HIV positive cases, we thus limited ourselves to a maximum of seven covariates per model. In our first model, we examined relevant individual risk factors for HIV among PWID; average weekly alcohol consumption in the past 12 months (above 14 units per week, below 14 units per week); unprotected sex (in the last six months, not in the last six months); cocaine injecting (in the last six months, not in the last six months); and injecting frequency (low frequency (less than four time per day), high frequency (4 or more times per day)). For our second model, we focussed on environmental risk factors; NESI survey year (2011-2014 (pre identification of the outbreak), 2015-2018 (post-identification of the outbreak); age at time of survey; biological sex; homelessness (in the last six months, not in the last six months); methadone status (prescribed in the last six months, not prescribed in the last six months); needle/syringe coverage per injection (<100%, 100%); and number of times in prison since first injected drugs (low number (five incarcerations or less) high number (more than 5 incarcerations)). In our third model, we combined the significant factors significant at the <10% level from the individual and environmental risk models.

All analysis was conducted using SPSS v21.

Role of the funding source

The funding source did not have any role in study design, data collection, analysis, or interpretation, in the writing of the report, or in the decision to submit this work for publication. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

In the overall GGC sample, HIV prevalence rose from 0·1% (95% CI: 0·0-0·6) in 2011-12 to 4·8% (95% CI: 3·4-6·2) in 2017-18 (Figure 1). This was mainly driven by increases in Glasgow City where HIV prevalence rose from 1·1% (95% CI: 0·2-6·2) in 2011-12 to 10·8% (95% CI: 7·4-15·5) in 2017-18 (Table 1).

INSERT FIGURE 1

For those testing HIV negative on DBS between 2011 and 2018, the average age of participants in the surveys significantly increased (Table 1). Other significant, but less linear, changes in trends were observed among those drinking, on average, above the recommended UK Government guidelines for weekly alcohol consumption (14 units for men and women). The proportion of male participants was largely stable across surveys, as was the proportion of participants with a high number of incarcerations and recent experience of homelessness. Prevalence of Hepatitis C also remained fairly stable across surveys, although prevalence amongst those surveyed in Glasgow city centre was typically higher than those recruited outside of the city centre.

Among those who tested positive for HIV infection on DBS between 2011 and 2018, the majority were male, although a third of HIV positive participants in 2017-18 were female. Similarly, the proportion with excessive alcohol consumption rose sharply in 2017-18. In addition, those testing positive for HIV appeared to have had a high number of incarcerations and to have had recent experience of homelessness. Prevalence of Hepatitis C among HIV infected cases was also considerably higher than in the HIV negative sample.

INSERT TABLE 1

In the HIV negative sample, a significant downward trend was observed over time for those who reported having unprotected sex in the past six months. Similarly, a significant trend in the proportion of individuals reporting injecting cocaine in the past six months was observed, rising sharply between 2015-16 and 2017-18. Significant increases were also notable when looking at those reporting injecting both heroin and cocaine and those reporting injecting heroin and cocaine together, often referred to as 'snowballing'. Trends in needle reuse, injecting frequency and needle/syringe sharing also significantly increased over time, however high frequency injectors (i.e. those at greatest risk) and those who reported sharing needles/syringes typically account for less than 10% of the sample within each survey.

In those who tested positive for HIV, the proportion injecting cocaine or both heroin and cocaine was considerably higher than among the HIV negative sample across the survey years with trends approaching significance. Rates of unprotected sex fluctuated but were notably highest when the outbreak was initially detected in 2015-16.

Among HIV negative participants, needle and syringe coverage in the past six months fluctuated over time but, on average, around 70% reported having sourced sufficient sterile equipment to cover all of their injections. However, significant trend changes in the proportion of those who had recently been prescribed methadone were observed but remained relatively high across surveys.

In those testing positive for HIV, significant trends in needle/syringe coverage per injection across surveys were observed. Notably where data was recorded, almost all the HIV positive cases participating in the 2017-18 survey reported adequate provision. Recent methadone prescription rates were also high across surveys among those testing positive for HIV.

In our first model, HIV infection was most strongly associated with cocaine injecting after accounting for other individual risk factors (Table 2). The association between high injecting frequency and HIV infection showed

borderline significance. We found no significant association between HIV infection and drinking above recommended weekly alcohol consumption guidelines or recent participation in unprotected sex.

INSERT TABLE 2

In our second model, HIV infection was most strongly associated with participation in more recent surveys (2015-16 and 2017-18), recent experience of homelessness and a high number of incarcerations since first injecting drugs, after accounting for other environmental risk factors (Table 3). We also observed a gender association, with females significantly more likely to be HIV positive than males. Age was also significantly associated: each year increase in age increased the likelihood of being HIV positive. We found no significant association between HIV infection and recent methadone prescribing or needle/syringe coverage.

INSERT TABLE 3

In our combined model, HIV infection was most strongly associated with history of cocaine injecting and participation in recent surveys after accounting for other indivdual and environmental risk factors (Table 4). Odds of HIV infection were also significantly higher for those with recent experience of homelessness and those with a high number of incarcerations since they first began injecting. Age also remained highly significantly associated with HIV. Increased risk of HIV among females in comparison to males showed borderline significance. We found no significant association between HIV infection and injecting frequency in our combined model.

INSERT TABLE 4

In sensitivity analysis, we included interaction effects between survey year, number of times in prison, homelessness, and cocaine injecting, in adjusted models (Appendix, page 1-3). The interaction coefficient in each model was not significant therefore it is unlikely that the strong association between cocaine injecting and HIV infection is dependent on survey year, incarceration history or recent experience of homelessness. In addition, we found no interaction effect between gender and survey year (Appendix, page 4)

Discussion

Prevalence of HIV infection among PWID in GGC increased markedly between 2011 and 2018. The highest rates were observed in Glasgow city centre where an outbreak of HIV among PWID was identified in 2015. Multivariate analysis highlighted that the strongest predictors of HIV infection among PWID in Glasgow were cocaine injecting and recent experience of homelessness.

In the context of outbreaks of HIV among PWID reported globally in the last 10 years, this is the first to investigate the determinants of infection using an approach which combines both statistical power and robust survey methods applied consistently over time. NESI is one of only four equivalent national serial bio-behavioural surveys of PWID worldwide and performs strongly in terms of coverage; typically recruiting 10-15% of the Scottish PWID population each survey compared to less than 5% in studies conducted in England, Canada and Australia. In comparison to other recent epidemiological studies of HIV outbreaks among PWID which have typically relied on reactive sampling methods conducted over relatively short time periods,[5,6,17] our study is the first to illustrate changes in HIV prevalence and risk factors among PWID over time and the impact of an outbreak on such trends. Moreover, the extensive bio-behavioural data available in NESI afforded us scope to consider a broad range of possible individual and environmental risk factors which few studies, to date, have been able to achieve.[15]

Cocaine injection is a well established risk factor for HIV infection.[18] The increasing trend toward cocaine injecting (50% in 2017-18) and its highly significant association with HIV infection among PWID in Glasgow is similar to recent shifts toward stimulant injecting observed among PWID elsewhere.[4] Stimulants have a short half-life which is known to increase injecting frequency,[19] and therefore BBV transmission risk, through reduced likelihood of using clean equipment at each injection.[20] This risk is compounded if there is a lack of effective prevention infrastructure, such was the case in Athens[6] and Indiana.[17] Glasgow, however, has widespread availability of free-to-access harm reduction services, including NSP and OAT. At the onset of the outbreak, the GGC region was distributing in excess of one million needles and syringes per year;[21] and there was a high self-reported uptake of injecting equipment among the HIV-positive cases (81% with 100%+ needle/syringe coverage). Uptake of OAT in these cases was also high (85% on OAT in the last six months) and

lacked association in our analysis, however this may not fully reflect breaks in treatment or optimised dosing of OAT during this period. This paradoxical scenario mirrors an outbreak of HIV among PWID in Vancouver (Canada) in the mid-1990s which occurred despite availability of NSP, OAT via methadone, and a range of social programmes.[18]

Cocaine injecting may also impact on sexual behaviours which increase vulnerability to HIV transmission. Users report numerous high risk sexual behaviours that include inconsistent condom use, multiple sexual partners, and sex with other people who use drugs.[22] Despite this established link, we found no significant association between HIV and unprotected sex in our sample. This could be due to a lack of statistical power or because sexual risk behaviour is strongly influenced by other individual or environmental factors we were unable to measure such as socio-economic status.[15] Lack of association may also be due to the time frame we used for unprotected sex (last six months) and our lack of information on exactly when HIV infection was transmitted. The high proportion of females in our HIV positive sample (25%) mirrors findings from outbreaks in Dublin[5] and Luxembourg,[4] and their elevated risk of HIV infection in our model reinforces the need to acknowledge the potential risk of sexual transmission in the Glasgow outbreak and to tailor prevention strategies accordingly.

In our study, cocaine injecting remained a highly significant predictor of HIV even after controlling for injecting frequency and unprotected sex. This suggests that there may be other unmeasured aspects of cocaine injecting that heighten the risk of HIV infection among PWID in Glasgow. Further research on the role of cocaine injecting facilitating and sustaining rapid transmission of HIV among PWID is merited.

It is unclear as to why there has been such a huge recent shift toward powder cocaine injecting by PWID in Glasgow, a locality where heroin has dominated the illegal drug market for decades. One explanation may be a reported decline in heroin purity within the UK,[23] research from Europe suggests cocaine purity is high at the moment –a characteristic which may have increased its attractiveness as an alternative to low quality heroin – and that 'high risk' cocaine use has increased in other European countries in recent years.[24] Future research should urgently address the motivations and patterns of stimulant injecting among current or former opioid users, in particular those with experience of homelessness, to inform policy and practice responses.

The strong link between homelessness and HIV infection provides additional evidence of the poor health outcomes and inequalities experienced by this population.[25] Socioeconomic issues were also common across the other recent outbreaks of HIV among PWID, with homeless populations disproportionately affected in the majority of incidents.[4] High prevalence of cocaine use among homeless populations has been documented previously.[26] The majority of these studies link homelessness with crack cocaine injecting, yet in Glasgow it is powder cocaine which has become endemic among homeless drug injectors.

Increases in homelessness in the UK have been observed since 2009.[27] In Glasgow, this has occurred alongside an ageing cohort of PWID with significant co-morbidities and experience of exclusion. It is estimated that there are up to 500 individuals regularly injecting in public places in Glasgow city centre, many of whom are homeless.[28] A needs assessment has highlighted the barriers to risk reduction behaviours in this population without addressing the existing social and addiction needs.[28] The high prevalence of hepatitis C (>90%) amongst the HIV infected group also suggests that sharing of injecting equipment, either directly or indirectly, is extensive. Awareness of HIV risk among PWID may also have been sub-optimal compared to previous generations given the low prevalence which has existed since the 1980s. An increase in cocaine injecting and declining heroin purity alongside this is likely to be contributing to risk taking. Combined, these multiple factors create a high risk environment for drug-related harm in Glasgow,[29] including rapid HIV transmission.

As the first formal epidemiological investigation into Glasgow's rapid HIV rise among PWID, this study has important implications for policy and practice. Primarily it will be of interest to policymakers focussed on reducing harms associated with drug use and achieving realistic public health goals such as HIV elimination.[30] An outbreak of HIV among PWID such as the one which has occurred in Glasgow threatens both these targets. Although our results are not directly generalisable, they should serve as a warning to countries with historically low HIV prevalence among PWID that things can change rapidly even with harm reduction services in place. Our findings also reinforce the importance of ongoing bio-behavioural surveillance initiatives among high risk groups in informing public health action. Studies such as NESI remain rare internationally despite the global health burden of HCV and HIV among PWID.

The response to the outbreak in Glasgow included an enhanced HIV model of care involving outreach nursing and community prescribing of anti-retroviral therapy (ART) that has engaged over 90% of the infected cohort in HIV treatment.[31] The barriers to achieving full risk reduction, particularly in excluded populations, highlight the importance of HIV treatment as prevention (TasP). The multi-disciplinary response has also included: HIV education to those at-risk and service providers; increased availability of HIV testing; improved provision of injecting equipment services; and developments within addictions care, including work to introduce a drug consumption room and heroin assisted treatment service.[28] This investigation highlights the importance of further work to review the addictions response to cocaine use in this population, including availability of psychosocial therapies and pharmacotherapy.

There are challenges, however, in the implementation of the more innovative elements of this response. Maintaining the extended injecting equipment provision services (i.e. services which provide needles, syringes, foil, water, filters and other injecting equipment) was set back by the closure of the city's largest NSP and whilst proposals to introduce a drug consumption room are approved locally and backed by the Scottish Parliament, sufficient legal exemptions have not been granted by the UK Government to allow it to operate.[28] The Heroin Assisted Treatment facility is not subject to the same legislative restrictions and is scheduled to open soon.

This study also has a number of limitations which we acknowledge. Firstly, we were unable to determine when the participants in our sample acquired their HIV infection, therefore it is possible that risk factor data collected at the time they were surveyed had changed since they became infected. To mitigate this, we included risk factor data collected when the infection was first detected in our study only, either within or across surveys. Our risk factor data is also mainly derived from self-reported responses which may be subject to response bias despite our use of independent researchers. The credibility of self-reported behaviours by drug users has been validated elsewhere[32] and we assume similar validity here. Our sample is biased towards those attending sites providing injecting equipment and PWID who do not regularly engage with such services may be underrepresented. However, evidence from GGC's own needs assessment[28] highlighted that PWID in Glasgow are regular attendees of city centre injecting equipment provision outlets. Lastly, although NESI includes a comprehensive range of individual and environmental risk factors, the potential for residual confounding in our study remains. For example, we were unable to determine changes in structure of injection networks of PWID in our sample over time, a variable which has been shown to impact HIV transmission.[33]

After nearly three decades of effective harm reduction and prevention, Glasgow is currently experiencing one of Western Europe's largest outbreaks of HIV among PWID. Lessons from Glasgow highlight that good availability of harm reduction services is not sufficient on its own to prevent outbreaks occurring among highly vulnerable populations. The risk environment in Glasgow in recent years has combined to develop a 'perfect storm' for rapid HIV transmission which has persisted for over three years despite a multi-disciplinary response. Our findings also demonstrate how critical robust surveillance, through regular HIV testing of high risk populations, is to ensure outbreaks are detected and rapid responses are informed by the best available evidence.

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AUTHOR CONTRIBUTIONS

AT, SJH and DJG conceived and designed the NESI survey. AT, SJH, NEP, AM and AMc implemented the survey. SS and RG analysed the DBS samples. AMc, NEP, and SJH contributed to study conception and data analysis. AMc, DJG, NEP, RM, CM, KT, AT, RG, AM, SS and SJH provided interpretation of findings. AMc wrote the first

draft of the manuscript, all remaining co-authors contributed to critical review and development of final manuscript.

FINANCIAL SUPPORT STATEMENT

This work was supported by funding from Health Protection Scotland.

CONFLICT OF INTEREST STATEMENT

SJH has received honoraria from Gilead, unrelated to this study. All remaining authors have nothing to disclose.

Table 1: Sample characteristics, risk behaviours, intervention coverage and HIV prevalence by survey year among PWID surveyed in Greater Glasgow and Clyde, 2011-2018.

	HIV negative					HIV positive			
	2011-12	**2013-14**	**2015-16**	**2017-18**	***p*[d,e]**	**2011-14**	**2015-16**	**2017-18**	***p*[d,e]**
Total participants recruited	*955*	*905*	*930*	*825*		*12*	*24*	*46*	
***Overall sample following de-duplication*[a]**	*926*	*855*	*892*	*782*		*11*	*23*	*39*	
Demographic and social characteristics									
Recruitment setting									
Glasgow inner city centre, n (%)	86 (9)	259 (30)	191 (21)	206 (26)	p<0.0001	*	13 (57)	25 (64)	p=0.159
Rest of NHS Greater Glasgow & Clyde (GGC), n (%)	840 (91)	596 (70)	701 (79)	576 (74)		*	10 (43)	14 (36)	
Missing, n (%)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)	0 (0)	
Gender									
Male, n (%)	683 (74)	607 (71)	645 (72)	591 (76)	p=0.317	*	*	26 (67)	p=0.068
Female, n (%)	241 (26)	243 (28)	242 (27)	186 (24)		*	*	13 (33)	
Missing, n (%)	2 (0)	5 (1)	5 (1)	5 (1)		0 (0)	1 (3)	0 (0)	
Age									
Mean (SD)	36 (6.16)	38 (7.08)	40 (7.13)	42 (6.97)	p<0.0001	45 (3.31)	41 (6.95)	42 (7.41)	p=0.280
Missing, n (%)	2 (0)	1 (0)	0 (0)	6 (1)		0 (0)	0 (0)	0 (0)	
Homeless in the previous six months?									
Yes, n (%)	183 (20)	236 (28)	177 (20)	199 (25)	p=0.138	*	8 (35)	21 (54)	p=1.000
No, n (%)	741 (80)	616 (72)	714 (80)	577 (74)		*	15 (65)	17 (44)	
Missing, n (%)	2 (0)	3 (0)	1 (0)	6 (1)		0 (0)	0 (0)	1 (3)	

Excessive alcohol consumption in the previous 12 months?									
Yes, n (%)	241 (26)	239 (28)	188 (21)	176 (23)	p=0.016	5 (45)	4 (17)	8 (21)	p=0.146
No, n (%)	683 (74)	615 (72)	683 (78)	592 (76)		6 (55)	17 (74)	29 (74)	
Missing, n (%)	2 (0)	1 (0)	7 (1)	14 (2)		0 (0)	2 (9)	2 (5)	
Number of times in prison since first injected drugs									
Low number (5 incarcerations or less)	556 (60)	505 (59)	537 (60)	444 (57)	p=0.398	2 (18)	8 (35)	14 (36)	p=0.359
High number (more than 5 incarcerations)	366 (40)	341 (40)	347 (39)	325 (42)		9 (82)	15 (43)	23 (59)	
Missing, n (%)	4 (0)	9 (1)	8 (1)	13 (2)		0 (0)	0 (0)	2 (5)	
Risk behaviours									
Had unprotected sex in the previous six months?									
Yes, n (%)	N/A	420 (49)	374 (42)	284 (36)	p<0.0001	3 (30)	12 (52)	9 (23)	p=0.359
No, n (%)	N/A	352 (41)	417 (47)	426 (55)		7 (70)	11 (48)	23 (59)	
Missing, n (%)	N/A	83 (10)	101 (11)	72 (9)		1 (9)	0 (0)	7 (18)	
Injected drugs in the previous six months?									
Yes, n (%)	805 (87)	706 (83)	715 (80)	523 (67)	p<0.0001	8 (73)	21 (91)	36 (92)	p=0.093
No, n (%)	121 (13)	147 (72)	176 (20)	251 (32)		3 (27)	2 (9)	2 (5)	
Missing, n (%)	0 (0)	2 (0)	1 (0)	8 (1)		0 (0)	0 (0)	1 (3)	
Injected drugs in the previous six months[b,c]									
Heroin, n (%)	755 (94)	614 (87)	659 (92)	455 (87)	p=0.003	5 (45)	16 (76)	28 (78)	p=0.212
Cocaine, n (%)	129 (16)	151 (21)	166 (23)	250 (48)	p<0.0001	4 (36)	19 (90)	30 (83)	p=0.066
Heroin and cocaine, n (%)	97 (12)	87 (12)	127 (18)	192 (37)	p<0.0001	1 (9)	15 (71)	22 (61)	p=0.060
Heroin and cocaine together, n (%)	26 (3)	28 (4)	30 (4)	70 (13)	p<0.0001	1 (9)	2 (10)	6 (17)	p=0.613
Missing, n (%)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)	0 (0)	

Average injecting frequency in the previous six months[b]									
Low frequency (less than 4 times per day)	750 (93)	643 (91)	664 (93)	476 (91)	p=0.325	7 (88)	12 (57)	31 (86)	p=0.414
High frequency (4 or more times a day)	55 (7)	62 (9)	50 (7)	47 (9)		1 (13)	9 (43)	5 (14)	
Missing, n (%)	0 (0)	3 (0)	2 (0)	0 (0)		0 (0)	0 (0)	0 (0)	
Shared needles/syringes in the previous six months?[b]									
No, n (%)	749 (93)	653 (92)	659 (92)	465 (89)	p=0.037	8 (100)	21 (100)	33 (92)	p=0.065
Yes, n (%)	54 (7)	44 (6)	49 (7)	52 (10)		0 (0)	0 (0)	3 (8)	
Missing, n (%)	2 (0)	9 (1)	7 (1)	6(1)		0 (0)	0 (0)	0 (0)	
Needle reuse in the previous six months[b]									
Never, n (%)	525 (65)	369 (52)	364 (51)	140 (27)	p<0.0001	5 (63)	8 (38)	9 (25)	p=0.092
Yes, n (%)	275 (34)	337 (48)	348 (49)	293 (56)		3 (38)	13 (62)	20 (56)	
Missing, n (%)	5 (1)	0 (0)	3 (0)	90 (17)		0 (0)	0 (0)	7 (19)	
Intervention coverage									
Syringe coverage in the previous six months[b]									
<100%, n (%)	214 (27)	105 (15)	239 (33)	125 (24)	p=0.111	2 (25)	8 (38)	2 (6)	p=0.012
100% +, n (%)	586 (73)	594 (84)	462 (65)	392 (75)		6 (75)	13 (62)	33 (92)	
Missing, n (%)	5 (1)	7 (1)	14 (2)	6 (1)		0 (0)	0 (0)	2=1 (3)	
Prescribed methadone in the previous six months?									
Yes, n (%)	814 (88)	602 (70)	709 (80)	627 (80)	p=0.016	11 (100)	16 (70)	31 (80)	p=0.365
No, n (%)	110 (12)	252 (30)	183 (21)	147 (19)		0 (0)	7 (30)	7 (18)	
Missing, n (%)	2 (0)	1 (0)	0 (0)	8 (1)		0 (0)	0 (0)	1 (3)	

BBV prevalence									
Valid DBS tests for HCV	**926**	**853**	**892**	**822**		**11**	**23**	**39**	
HCV antibody prevalence, n (%)	584 (63)	592 (69)	575 (65)	520 (67)	p=0.606	10 (91)	22 (96)	37 (95)	p=0.981
Glasgow inner city centre, n (%)	65 (76)	199 (77)	124 (65)	156 (76)	p=0.452	4 (100)	13 (100)	25 (100)	p=1.000
Rest of NHS GGC, n (%)	519 (62)	393 (66)	451 (64)	364 (63)	p=0.612	6 (86)	9 (90)	12 (86)	p=0.691

ALL PARTICIPANTS

	2011-12	**2013-14**	**2015-16**	**2017-18**	
Valid DBS tests for HIV	***927***	***905***	***915***	***821***	
HIV antibody prevalence, n (%)	1 (0.1)	10 (1.1)	23 (2.5)	39 (4.8)	p<0.0001
Glasgow inner city centre, n (%)	1 (1.1)	3 (1.1)	13 (6.3)	25 (10.8)	p<0.0001
Rest of NHS GGC, n (%)	0 (0)	7 (1.1)	10 (1.2)	14 (2.4)	p<0.0001

[a] Denominators do not always match overall sample totals due to missing or insufficient data
[b] Among injectors who report injecting drugs in the last six months
[c] Percentages will add up to more than 100% as individuals may have reported use of more than one drug
[d] Chi-square test for trend for categorical variables
[e] one-way ANOVA test for continuous variables
* Data suppressed to minimise risk of deductive disclosure

Table 2: Odds ratios (ORs), Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) for individual factors associated HIV infection among PWID in Greater Glasgow and Clyde, 2011-2018.

		Adjusted model overall sample (n = 2591)			
	HIV+, n (%)*	**OR (95% CI)**	***p***	**AOR (95% CI)**	***p***
Excessive alcohol consumption in the last 12 months					
No	48 (74)	1.0		1.0	
Yes	17 (26)	1.1 (0.6-1.9)	0.78	0.8 (0.5-1.5)	0.49
Had unprotected sex in the last six months					
No	41 (59)	1.0		1.0	
Yes	21 (30)	0.6 (0.3-1.0)	0.044	0.6 (0.4-1.1)	0.090
Not recorded	7 (10)	0.2 (0.1-0.4)	<0.0001	0.2 (0.1-0.5)	0.00030
Injected cocaine in the last six months					
No	19 (20)	1.0		1.0	
Yes	49 (80)	11.3 (6.6-19.4)	<0.0001	9.0 (5.2-15.8)	<0.001
Average injecting frequency in the last six months					
Low frequency (4 times per day or less), n (%)	55 (80)	1.0		1.0	
High frequency (4 or more times a day), n (%)	14 (20)	4.0 (2.2-7.3)	<0.0001	1.8 (0.9-3.7)	0.083

*not all values add up to 69 due to missing data

Table 3: Odds ratios (ORs), Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) for environmental factors associated HIV infection among PWID in Greater Glasgow and Clyde, 2011-2018.

		Adjusted model overall sample (n = 2526)			
	HIV+, n (%)*	**OR (95% CI)**	***p***	**AOR (95% CI)**	***p***
NESI survey					
2011-12 and 2013-14	11 (16)	1.0		1.0	
2015-16 and 2017-18	58 (84)	6.0 (3.1-11.4)	<0.0001	5.8 (2.9-11.3)	<0.0001
Age					
Age (Per Year Increase)	69 (100)	1.1 (1.0-1.1)	<0.0001	1.1 (1.0-1.1)	0.0037
Gender					
Male	51 (75)	1.0		1.0	
Female	17 (25)	0.9 (0.5-1.6)	0.73	1.9 (1.0-3.7)	0.081
Homeless in the last six months					
No	31 (46)	1.0		1.0	
Yes	37 (54)	4.2 (2.6-6.8)	<0.0001	4.1 (2.5-6.9)	<0.0001
Number of times in prison since first injected drugs					
Low number (5 incarcerations or less)	23 (34)	1.0		1.0	
High number (more than 5 incarcerations)	44 (66)	3.1 (1.9-5.2)	<0.0001	2.9 (1.7-5.1)	0.00014
Prescribed methadone in the last six months					
No	10 (15)	1.0		1.0	
Yes	58 (85)	1.3 (0.7-2.6)	0.41	0.7 (0.3-1.5)	0.40
Syringe coverage in the in the last six months					
<100%	11 (16)	1.0		1.0	
100%+	48 (71)	1.4 (0.7-2.6)	0.36	1.6 (0.8-3.0)	0.19
Did not inject in the last six months	9 (13)	0.6 (0.2-1.6)	0.34	0.5 (0.2-1.3)	0.17

*not all values add up to 69 due to missing data

Table 4: Odds ratios (ORs), Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) for individual and environmental factors associated with HIV infection among PWID in Greater Glasgow and Clyde, 2011-2018.

		Adjusted model overall sample (n = 2586)			
	HIV+, n (%)*	**OR (95% CI)**	***p***	**AOR (95% CI)**	***p***
NESI survey					
2011-12 and 2013-14	11 (16)	1.0		1.0	
2015-16 and 2017-18	58 (84)	6.0 (3.1-11.4)	<0.0001	3.4 (1.7-6.7)	0.00052
Age					
Age (Per Year Increase)	69 (100)	1.1 (1.0-1.1)	<0.0001	1.1 (1.0-1.1)	0.0016
Gender					
Male	51 (75)	1.0		1.0	
Female	17 (25)	0.9 (0.5-1.6)	0.73	1.7 (0.9-3.2)	0.083
Homeless in the last six months					
No	31 (46)	1.0		1.0	
Yes	37 (54)	4.2 (2.6-6.8)	<0.0001	3.0 (1.7-5.0)	<0.0001
Number of times in prison since first injected drugs					
Low number (5 incarcerations or less)	23 (34)	1.0		1.0	
High number (more than 5 incarcerations)	44 (66)	3.1 (1.9-5.2)	<0.0001	2.1 (1.2-3.7)	0.0098
Injected cocaine in the last six months					
No	19 (20)	1.0		1.0	
Yes	49 (80)	11.3 (6.6-19.4)	<0.0001	6.7 (3.8-12.1)	<0.0001
Average injecting frequency in the last six months					
Low frequency (less than 4 times per day)	47 (77)	1.0		1.0	
High frequency (4 or more times a day)	14 (23)	4.0 (2.2-7.3)	<0.0001	1.7 (0.8-3.4)	0.14

*not all values add up to 69 due to missing data

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